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EUROPEAN SCIENTIFIC NOTES

15 August 1952

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A SPACE-CHARGE ACCELERATOR FOR PROTONS

Professor H. Alfvén of the Royal Institute of Technology, Stockholm, has described a new method for the acceleration of nuclear particles. A preliminary account of the idea has already appeared in the Arkiv för Fysik 5, 175 (1952). Since then a more detailed proposal has been made, and apparatus is being constructed to test the ideas experimentally.

To decrease the length of linear accelerators, it is necessary to use very high electric field strengths for acceleration. Alfvén has suggested the use of the strong Coulomb field in the vicinity of a dense electron cloud moving with an appropriate speed. One of the advantages of this method is that it utilizes the self-focusing force between the proton and the negative space charge.

A sheet of electrons is emitted from a long cathode and focused along the path of the protons so that the paths of the individual electrons cross the proton path at right angles. An electromagnetic wave traveling along a Lecher-wire system is used to split up the space-charge sheet into well focused electron clouds which proceed with the wave. The phase velocity of the traveling wave is adjusted by means of loading capacities between the Lecher wires (Fig. 1).

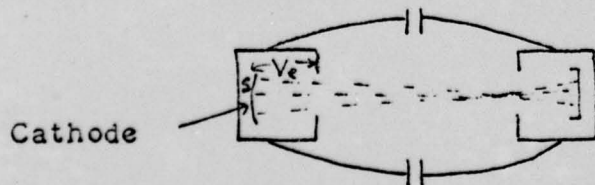


Figure 1.

A beam of positive ions is shot along the line on which the focus proceeds (Fig. 2).

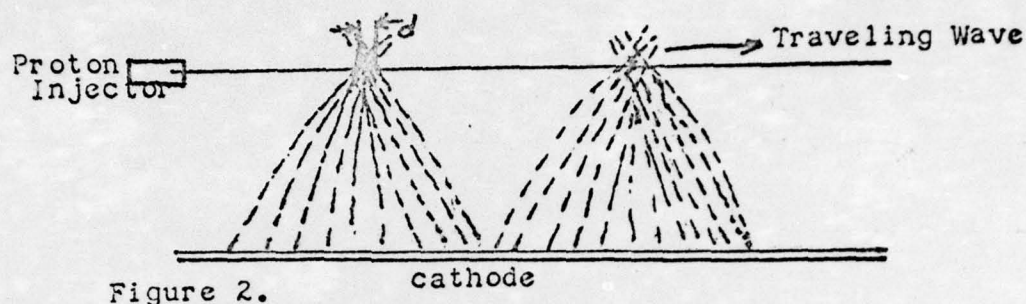


Figure 2.

If the velocity of the ions equals the velocity of the focus (i.e. the phase velocity of the waves along the Lecher systems) the ions which are somewhat behind the focus will be accelerated by the space charge field of the electrons at the focus. If the phase velocity of the Lecher system is higher at the end than at the beginning, the focus will increase its velocity and the ions behind the focus will be continuously accelerated. In a certain region near the focus the ions will be in an equilibrium which is believed to be stable both in the longitudinal and transverse directions.

The accelerating field experienced by a proton in this apparatus turns out to be  $\sim V/d$ , where  $V$  is the cathode voltage (or electron energy) and  $d$  the thickness of the electron cloud in the direction of propagation. At present a model is under construction with  $V_e = 10$  kv to test the idea. It is hoped next to achieve  $V_e = 50$  kv,  $d = 0.2$  cm, which would give a field strength  $E = 2.5 \times 10^5$  v/cm.

An alternative focusing arrangement for the electrons using a static magnetic field is under investigation experimentally (Fig. 3) and is hoped to give an electric field strength of  $\sim 10^6$  y/cm. This problem is being attacked by several workers in Alfvén's laboratory.

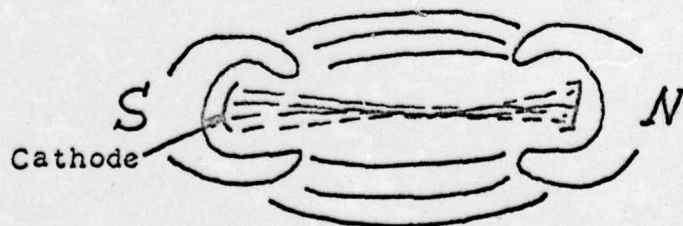


Figure 3.



## QUICK TEST OF MECHANICAL IRREGULARITIES OF A MICROSCOPE STAGE

In the study of tracks of ionizing nuclear particles in photographic emulsions the measurement of the multiple scattering of the track plays an important role. In order to obtain accurate values for the multiple scattering it is essential to have a microscope whose stage possesses completely linear movement and hence does not contribute appreciably to the scattering by its own irregularities. Such irregularities arise from mechanical errors, dust particles, and temperature gradients.

R.M. Tennent of Imperial College, London, has investigated methods for measuring quickly and conveniently the straightness of a microscope stage movement. An optical method, using a Michelson interferometer whose mirror is attached to the stage of the microscope, provides a test which is independent of the optical system of the instrument. However, as a quick check, the measurement of the "multiple scattering" of a known straight line is to be preferred. Tennent uses a stretched quartz fiber for this purpose.

Previously, unsupported stretched quartz fibers had been used as reference lines, but these were found to be unsatisfactory because they had to be examined with a dry objective of low magnification (and hence low resolution). Also, being transparent and colorless, they were difficult to observe.

A simple procedure for producing a permanent straight line was developed. A quartz fiber is stretched over a clean glass plate and held in position by shellac at both ends. The plate and fiber are then silvered by direct sputtering in a vacuum, and the fiber peeled off leaving a shadow of unsilvered glass about 2.5 microns in width. The silver plate is then coated with a thin layer of collodion. Such a plate has been in constant use for the past few months without showing any signs of deterioration.

## THE THERMODYNAMICS OF CLATHRATES

The occlusion compounds formed by hydroquinone with numerous gases have been studied systematically by H.M. Powell and his associates (Oxford) by means of X-ray crystallography (cf. ESN 4, 81 (1950), and numerous publications in the J.Chem. Soc). The thermodynamics and thermochemistry of some of these clathrates are also being

investigated in several other laboratories. The results obtained by D.F. Evans and R.E. Richards (Oxford) indicate that the formation of these compounds is strongly exothermic and that the enthalpy change is roughly proportional to the polarizability of the occluded molecules. It is also proportional to the extent to which the lattice is filled with gas. Some of the conclusions reached by W.F.K. Wynne-Jones (Newcastle) on the basis of vapor pressure studies do not appear to agree with these views, however.

The thermochemical investigations of Evans and Richards were performed in a new twin differential compensating calorimeter. This calorimeter is made entirely of glass including the heater, thermometers, stirrer, and breaker to fracture the sample bulbs. The first investigation, to be published soon in the J. Chem. Soc. (London), dealt with the heat of transition from  $\alpha \rightarrow \beta$  hydroquinone. This was a fundamental quantity needed in the work because the crystal structure of  $\beta$ -hydroquinone in the clathrates is different from the ordinary  $\alpha$ -hydroquinone (J. Chem. Soc. 815, (1948)). Using this quantity, the heats of solution of the hydroquinone clathrates containing argon, nitrogen, hydrogen chloride, methanol, sulfur dioxide, and acetic acid were compared with the heats of solution of the pure solid. As the dissolution process is endothermic the temperature change could be compensated by heating. The heats of formation of the clathrates increase in the order listed from about 6 to 11 Kcal/mole.

Wynne-Jones reported recently on some equilibrium vapor pressure determinations on the hydroquinone clathrates containing methanol and sulfur dioxide. The Clausius-Clapeyron equation indicated heats of vaporization of 9.2 and 14.2 Kcal/mole respectively. The value for methanol is about equal to the heat of sublimation of pure methanol, suggesting that in this case the heat of formation of the clathrate is zero, and that its stability is due to an entropy term. The value obtained for sulfur dioxide in its clathrate is considerably larger than the heat of vaporization of bulk  $\text{SO}_2$ , suggesting a heat of formation of about 9 Kcal/mole, which would be in rough agreement with the direct value obtained by Evans and Richards.

#### AERODYNAMIC FLOW ANALOGS

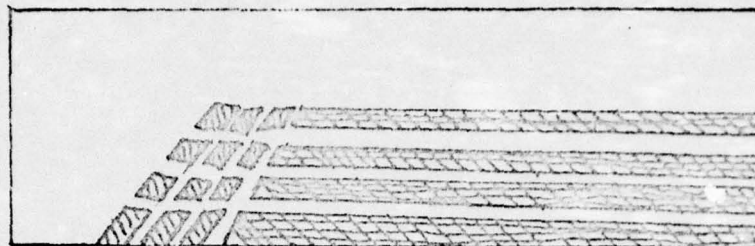
The Computation Laboratory of the Office National d'Etudes et de Recherches Aeronautiques, Paris, under the direction of Dr. L. Malavard, is developing electrolytic analogs for the potential flow around aircraft wings.



For wings of constant profile the following technique has been successfully employed in order to determine the induced airstream velocities: first the two-dimensional flow around the profile is realized in an electrolytic tank in which the equipotentials represent the streamlines of the air flow. For this purpose a conducting model of the air foil section is placed in an originally uniform electric current field whose equipotentials represent the streamlines of the undisturbed flow; a current is then supplied to the model until the family of equipotentials of the disturbed field satisfies the Kutta-Joukowski condition of having no singularity at the trailing edge. With the strength of the original field modelling the flow velocity at infinity, the current thus determined is analogous to the circulation. In order to determine the induced velocity field around a wing of finite span possessing the above profile over its entire width, an electromagnetic analogy is used. The wing appears as a finite segment of a vortex filament to whose end points the filaments of the tip vortices are attached, running downstream to infinity. A wire is shaped to represent this configuration which looks like three sides from the periphery of a very elongated rectangle where the tip vortex filaments are represented by the two long sides and the wing by the short side connecting them. When supplied with the current found in the electrolytic tank experiment, this wire will be surrounded by a magnetic field which, except for calibration constants, is the field of induced velocities around the wing.

The three dimensional flow over a lifting surface of finite plan form can be modelled approximately in an electrolytic tank by realizing its velocity potential as that due to an originally uniform field which is disturbed by appropriate electrical sources and sinks. This uniform field is established between a pair of conducting sides of the tank and is in the direction of the undisturbed air flow. The bottom of the tank is a plastic sheet on which the plan form of the lifting surface and its downstream wake are outlined. The former is paved with many small electrodes into which differential currents are fed in a manner representing the local inclination of the presumed lifting surface. The area downstream from the latter is paved with long conducting strips in the direction of the modelled air flow. Each of them is maintained at the potential prevailing at the point of the trailing edge where it meets the latter (Figure 1.). In this fashion the Kutta-Joukowski condition is once more satisfied, and the potential now prevailing in the tank duplicates reasonably well the velocity potential of the corresponding steady air flow.

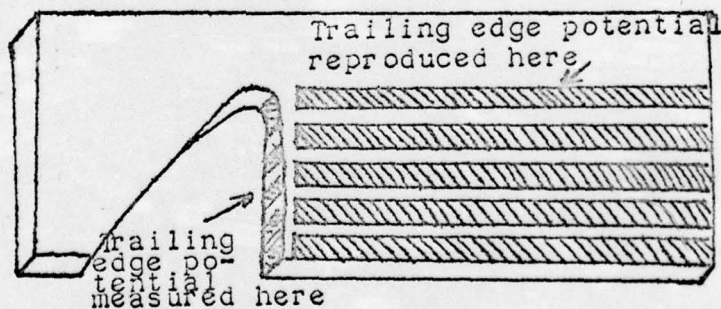




Model of Swept Back Wing  
(Shaded areas are conducting)

Figure 1.

A particularly ingenious method has been found for the case where the lifting surface is a plane lying in the flow field at a constant angle of attack. Instead of supplying the electrodes of the lifting surface all with the same current, the entire area of the lifting surface is cut out of the plastic sheet and a uniform field normal to its plane is applied over this area. It is now necessary to maintain the trailing edge potential in the strip electrodes downstream from the lifting surface. For this purpose small electrodes are placed on the vertical edge of the cut-out; the potential is measured at these electrodes and then reproduced in the corresponding strips (Figure 2).



Model of Lifting Surface at Constant Angle  
of Attack

Figure 2.

In order to realize the proper electrode configuration on the sheets of plastic, narrow strips of adhesive tape are laid on to mask the areas to be maintained non-conducting. The masked plate is then painted

with a conducting silver paint; the adhesive tape is removed and the configuration is ready for insertion into the tank. This technique is currently applied also to a problem which originated in the David Taylor Model Basin. It is that of realizing by a stationary current field in an electrolyte the flow field around a towed ship model. Assuming one of the vertical walls of the tank to be the median plane of the model, the area of the wall occupied by the latter is again paved with small individual electrodes. Current is supplied to or withdrawn from each of them individually in such a fashion that values of the potential are realized on the locus of the model's hull which match those having been found in an actual towing test. In this fashion a source-and-sink equivalent is found for a given hull configuration.

#### CAPILLARY DAMAGING EFFECTS OF IRON

At a meeting of the Physiological Society in Oxford on 18-19 June, J.A. Nissim of Guy's Hospital Medical School, London, reported observations on the pharmacological effects of iron salts.

Marked capillary oedema without hemorrhage has been noticed in lung sections of animals receiving ferric glucosate in doses of 20 mg of iron per kilogram. Higher dose levels produced hemorrhagic lesions which were evidently due to a combination of marked capillary injury and the anticoagulant effect of iron. After fatal doses of ferric chloride lactate, pulmonary oedema was the presenting toxic feature and appeared to be the immediate cause of death. Histologic study has shown that capillary injury is produced by many iron preparations and a triad of pathologic responses as oedema, semicollapse, and hemorrhage can be demonstrated. When the production of capillary injury is associated with high anticoagulant activity, as in the case of "ferrous chloride ascorbate", massive pulmonary hemorrhages result. Capillary injury seems to play an important role in the toxicity of "ferric hydroxide ferrous ascorbate", ferrous ascorbate, ferric ammonium citrate, ferric tartrate, and Ferronascine (Roche). Saccharated iron oxide appears to possess the least capillary damaging effect in addition to being the least active anticoagulant. The mechanism by which this capillary injury is produced is independent of the diffusibility (or particle size), precipitation, or valency of the iron in the preparation.



### CYSTEINAMINE FOR PROTECTION AGAINST IONIZING RADIATIONS

At the Physiological Society Meeting mentioned above, Professor Z.M. Bacq and A. Herve of the Departments of General Pathology and Radiotherapy, University of Liège, Belgium, reported that cysteinamine given in a dosage of 200 mg intravenously to human subjects undergoing radiation therapy can reduce and in many instances nearly abolish symptoms characterizing the radiation syndrome.

The investigators have studied the protective effect on animals of 45 substances bearing the amino group and have found that in all instances amines gave better protection than the corresponding amino acids, but the protection was greatest with cysteinamine.

Maximum protection is afforded the patients only if given just prior to radiation therapy. None is observed if given immediately after exposure. (cf. ESN 6, 138 (1952)).

### OBSERVATIONS ON VASCULAR RESPONSES IN THE RABBIT'S EAR

Changes in the amount of blood in a rabbit's ear have been recorded by S.M. Hilton and Pamela Holton of the Physiological Laboratory, University of Cambridge, using a photoelectric method described by Holton and Perry in 1951 and, at the same time, the venous outflow has been measured by means of a plastic drop chamber developed by Hilton.

In this latter device, which will be described in the Journal of Physiology, the blood is passed in a closed circuit through a chamber after a selected vein is cannulated with two lengths of polyethylene tubing. The drops of blood, falling in air, are momentarily in contact with the electrodes, and the rate of drop formation is recorded in any convenient way. In the report and exhibition of their observations at the Cambridge Meeting of the Physiological Society, both the changes in amounts of blood in the ear and the flow of blood were recorded on smoked drums.

The photocurrent is affected predominantly by changes in the patency and diameter of the smallest vessels (mainly capillaries), whereas the volume outflow indicates the state of the vessels presenting the main resistance to flow. The simultaneous use of both methods thus allows more precise information to be obtained than is possible with either method alone.



Arterial injections of small doses of histamine give rise to capillary dilatation (sometimes preceded by constriction), during which the flow may be considerably reduced. Similarly, small doses of adrenaline often cause a capillary dilatation, while the flow is unaffected or slowed. Acetylcholine in small doses was found to result in dilatation of both arteries and capillaries. The investigations pointed out that these observations serve to emphasize that the terms "vasoconstriction" and "vasodilatation" must be used with care.

#### OCCURRENCE OF VITAMIN B<sub>12</sub>, FOLIC, AND FOLINIC ACID IN SEAWEED

Dr. L.E. Ericson of the Royal Institute of Technology, Stockholm, has studied various species of brown and red seaweed from the Baltic and North Seas to determine whether and in what amounts vitamin B<sub>12</sub>, folic, and folinic acids occurred in these plants. Three brown seaweeds, Sphacelaria arctica, Laminaria saccharovia, and Fucus vesiculosus, and three red seaweeds, Furcellaria fastigiata, Polysiphona nigrescens, and Rhodomela subfusca were reported on by Ericson at the International Symposium on Seaweed Research held in Edinburgh 14-17 July 1952.

Vitamin B<sub>12</sub> in the form of B<sub>12b</sub> was found in all species of the six weeds examined and B<sub>12b</sub> varied from 0.5 to 1.0 mg per gram of dry weight. The content of B<sub>12</sub> in some samples seems to be comparable with that of liver.

The testing of vitamin B<sub>12</sub> activity was done using Lactobacillus lactis and L. leishmanii.

All seaweeds contained folic and folinic acid except Rhodomela.

#### MICROBIOLOGY OF DRIED AND LIQUID BULK EGGS

A symposium on food preservation was held in Cambridge on 24 July at which time Mr. N.R. Knowles of Belfast indicated that since chipped and second grade eggs were used in the preparation of dried egg yolk, a figure as low as five million organisms per gram would be a meritorious achievement in providing eggs intended for human consumption.

Although hens' eggs are seldom incriminated in food poisoning it is significant to report that of 144 random samples taken from processing plants in Ireland over the past seven months, six were positive for Salmonella; four of these yielded Salmonella typhi murium. Samples of liquid bulk duck eggs were shown to be frequent conveyors of Salmonella, particularly S. typhi murium. This emphasizes that ducks can be symptomless faecal excretors of Salmonella typhi murium and that their eggs, if ingested, may cause acute gastro-enteritis. In this connection it is of further interest to note that in the 19 July issue of the British Medical Journal, two fatal and two severe cases of food poisoning due to duck eggs were reported. By means of bacteriophage typing of the strains of Salmonella typhi murium and by agglutination tests on duck sera the incriminated eggs were traced to the appropriate flocks of ducks.

#### TECHNICAL REPORTS OF ONRL

The following reports have been forwarded to ONR, Washington, since the last issue of ESN. Copies may be obtained from the Technical Information Office, Code 250, Office of Naval Research, Washington 25, D.C.

- ONRL-51-52 "E.M.I. Photomultiplier Tubes" by W.L. Hyde
- ONRL-63-52 "Experimental Psychology in Italy" by H.A. Imus
- ONRL-64-52 "The Burch Reflecting Microscope" by W.L. Hyde
- ONRL-68-52 "Nuclear Chemistry Research at Chalmers Institute of Technology" by R.W. Mooney
- ONRL-69-52 "The Inaugural Meeting of AGARD" by F.J. Weyl
- ONRL-70-52 "The Program of the Istituto Nazionale per le Applicazioni del Calcolo" by F.J. Weyl
- ONRL-72-52 "Copenhagen Conference on Nuclear Physics and Elementary Particle Physics" by S.F. Singer
- ONRL-73-52 "The Influence of 'Adaptinol' and Vitamin A on Night Vision" by H.A. Imus
- ONRL-74-52 "Research in Physiological Psychology" by H.A. Imus



## REPORT OF MEDICAL RESEARCH COUNCIL, GREAT BRITAIN 1950-51

The 37th annual report of the Medical Research Council covering the year ending September 30, 1951, was published recently. It follows the pattern established last year of describing progress in a selection of the scientific fields in which the Council is promoting research. These fields are: (a) proteins, (b) the preservation of living cells at low temperatures, (c) statistics in medical research, (d) infectious diseases, (e) recent work on antibiotics, (f) diseases of the eye, (g) skin disease, (h) the experimental study of human skill, (i) climatological medicine, (j) malaria, (k) chemical agents in the causation of cancer, and (l) cortisone and ACTH.

The annual cost to public funds for maintaining these research projects is roughly £1,500,000 with rather more than £250,000 extra for capital expenditure on buildings and major equipment.

The report is printed and published by Her Majesty's Stationary Office, 423 Oxford Street, London, W.1. The price is six shillings.

### PERSONAL NEWS ITEM

Three recent appointments of astrophysicists in the London area have been announced.

Professor V.C.A. Ferraro, until recently at University College, Exeter, has been appointed Professor at Queen Mary College, University of London, to take the place of Professor G.C. McVittie, who is now at the University of Illinois.

Professor Ferraro is well known for his work in collaboration with Professor Chapman on the theory of magnetic storms and aurora and for the mathematical treatment of the motion of a neutral ionized stream in a magnetic field. Most recently his work has been concerned with the problem of stars having a variable magnetic field.

Dr. T. Gold of the Cavendish Laboratory, Cambridge, has been appointed a Chief Assistant at the Royal Greenwich



Observatory, Herstmonceux, Sussex. Dr. Gold has achieved prominence by his collaboration with Bondi on the theory of continuous creation. He has most recently been concerned with magnetohydrodynamics and the problem of the polarization of starlight. Dr. Gold was the first to suggest at a conference on the "Dynamics of Ionized Media" in London, that point sources of radio noise (the so-called radio stars) may be of extragalactic origin and identifiable with galaxies whose spectra indicate highly turbulent motion.

Dr. P.A. Sweet, who was most recently at the University of Glasgow, has been appointed Assistant Director of the University of London Observatory at Mill Hill, whose Director is Professor C.W. Allen. Dr. Sweet will be concerned with theoretical astronomy; his special interest has been problems on cosmic magnetic fields.

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